CLAIMS

What is claimed is:

1. A steering control apparatus for a steering system of a vehicle having at least one steerable member movable in response to a steering force to either side of a selected center position relative to frame means for carrying the steerable member, said apparatus comprising:

a rotary cam member mounted for rotation about an axis and having a corresponding face with at least one centering detent;

a piston cam member having a corresponding face arranged opposite to the rotary member face with a centering detent aligned with each rotary member detent when the rotary cam member is in a centered position corresponding to the selected center position of the steerable member, each of the piston member detents and rotary member detents comprising a seat;

a bearing member arranged to be pressed between the rotary and piston cam members and to be in a seated position in contact with the seats of the aligned centering detents when the steerable member is in the selected center position;

rotation means for rotating the rotary cam member relative to the piston cam member in response to movement of the steerable member away from the selected center position;

pressing means for pressing together the piston and rotary cam members so that contact pressure between the bearing member and the seats of the aligned centering detents causes a resistance force that resists relative movement between the rotary cam member and the piston cam member and prevents substantial movement of the steerable member away from the selected center position until the steering force exceeds a predetermined value; and,

trim means for changing a center position of said piston cam member so as to selectively vary said selected position of said steerable member while said vehicle is in operation, said trim means comprising:

a clutch ring mounted in a fixed position relative to the frame means and a clutch disk arranged for releasably engaging the clutch ring,

connecting means for connecting the piston cam member for rotation with the clutch disk while permitting relative axial movement between the piston cam member and the clutch disk,

positioning means for momentarily releasing said clutch disk from engagement with said clutch ring in response to at least one remote input, said clutch disk when released being rotatable with said piston cam member in response to movement of said bearing member by

rotation of said rotary cam member such that the center position of said piston cam member can be changed between a plurality of static rotational positions relative to the frame means,

and control means for selectively providing said at least one remote input to said positioning means from a location remote to said clutch disk and piston cam member.

2. The apparatus of claim 1, wherein said connection means comprises at least one guide member fixed to one of said piston cam member and said clutch disk and extending into and arranged for sliding movement within a corresponding guiding receptacle of the other of said piston cam member and said clutch disk, said guide member movement guiding axial movement of said piston cam member relative to said clutch disk in response to movement of said bearing member away from said detent seat.

3. The apparatus of claim 2, wherein said guide member comprises at least one guide pin fixed to one of said piston cam member and said clutch disk and extending into and arranged for sliding movement within a corresponding bore of the other of said piston cam member and said clutch disk, said sliding pin movement guiding axial movement of said piston cam member relative to said clutch disk in response to movement of said bearing member away from said detent seat and also axial movement of said clutch disk relative to said piston cam member when said clutch disk is released from engagement with said clutch ring in response to said remote input.

4. The apparatus of claim 2, wherein said guide member comprises at least one guide lug fixed to one of said piston cam member and said clutch disk and extending into and arranged for sliding movement within a corresponding receptacle of the other of said piston cam member and said clutch disk, said receptacle having opposing sides formed by opposing ears upstanding from said other of said piston cam member and said clutch disk, and said opposing receptacle sides guiding said sliding lug movement and axial movement of said piston cam member relative to said clutch disk in response to movement of said bearing member away from said detent seat.

5. The apparatus of claim 1, wherein said positioning means comprises actuating means and bearing means for rotatably mounting said clutch disk on a support member of said actuating means, said actuating means being responsive to said remote input for causing said clutch disk to reciprocate between a released position at which said clutch disk is released from engagement

with said clutch ring and an engaged position at which said clutch disk is frictionally engaged by said clutch ring.

6. The apparatus of claim 5, wherein said actuating means comprises a trim piston arranged for axial reciprocation within a trim chamber pressurizable by introduction of a fluid therein in response to said remote input, and engaging means for causing said clutch disk reciprocation in response to reciprocation of said trim piston.

7. The apparatus of claim 6, wherein said bearing means is carried by the support member of said actuating means, and wherein said engaging means comprises at least one elongated trim bar arranged for pivotal movement in a longitudinal plane of the bar for causing axial movement of the support member in response to said axial reciprocation of the trim piston, said trim bar having a proximate end mounted on said trim piston for said pivotal movement and an elbow adjacent a distal end arranged to function as a fulcrum for said pivotal movement.

8. The apparatus of claim 6, wherein said bearing means is carried on the support member of said actuating means, wherein said support member and said trim piston are arranged for axial movement relative to each other, and wherein said positioning means further comprises at least one guide post fixed within a corresponding bore of one of said trim piston and said support member and extending into and arranged for sliding movement within a corresponding bore of the other of said trim piston and said support member, said sliding post movement guiding said relative axial movement.

9. The apparatus of claim 6, wherein said bearing means is carried on the support member of said actuating means, wherein said support member and said trim piston are arranged for axial movement relative to each other, wherein said positioning means further comprises a guide post fixed to said trim piston and extending into and arranged for sliding movement within a corresponding bore of said support member, said sliding guide post movement guiding said relative axial movement, and wherein said apparatus further comprises casing means for holding said trim piston at a fixed axial position relative to said rotary cam member.

10. The apparatus of claim 9, wherein pressurization of said trim chamber causes said trim piston to move said clutch disk to its release position, and wherein said apparatus further

comprises trim spring means engaged between said guide post and said support member for returning said moved clutch disk to its engaged position with said clutch ring when said trim chamber is depressurized.

11. The apparatus of claim 1, wherein each of the piston member detents and rotary member detents comprise opposing ramps one on each side of the detent seat and each inclined away from the seat up toward said opposing faces, wherein relative movement between the rotary cam member and the piston cam member causes said bearing member to move up one or the other of said opposing detent ramps, and wherein said pressing means provides contact pressure between said ramps and said moved bearing member for causing a return force resisting said up ramp movement and biasing said moved bearing member toward said seated position.

12. The apparatus of claim 11, wherein each of said ramps is formed with a groove having substantially the same radius as the bearing member to provide a snug fit and firm frictional engagement for driving the bearing member out of the seat and up along the ramp upon rotation of the rotary cam member.

13. The apparatus of claim 12, wherein each of said ramps is fared into a corresponding track for receiving the bearing member upon movement thereof away from a corresponding detent.

14. The apparatus of claim 13, wherein each of the tracks is formed by a groove having substantially the same radius as the bearing member.

15. The apparatus of claim 1, wherein said pressing means comprises adjusting means operable for varying the contact pressure between the bearing member and the aligned detents so as to vary the amount of steering force required for movement of the steerable member away from the selected center position, and control means for remotely operating the adjusting means so as to selectively vary the amount of the contact pressure while the vehicle is in operation.

16. The apparatus of claim 15, wherein said pressing means further comprises fluid means for providing a pressurized fluid in a centering chamber for biasing the piston cam member

toward the rotary cam member, and wherein said adjusting means comprises means for varying the pressure of the fluid in said centering chamber to change the amount of contact pressure provided against the bearing member by the rotary and piston cam members.

17. The apparatus of claim 1, wherein said pressing means comprises fluid means for providing a pressurized fluid in a centering chamber for biasing the piston cam member toward the rotary cam member, and spring means for biasing the piston cam member toward the rotary cam member so that contact pressure between the bearing member and the aligned detents is maintained in the absence of fluid pressure in said centering chamber.

18. The apparatus of claim 17, wherein said centering chamber and said spring means are arranged so that fluid pressure in said centering chamber and a spring force of said spring means also biases said released clutch disk into frictional engagement with said clutch ring in the absence of said remote input.

19. The apparatus of claim 1 comprising a plurality of bearing members, and wherein the rotary and piston cam members each have a plurality of centering detents one for receiving each of the plurality of bearing members.

20. The apparatus of claim 1 comprising a plurality of said bearing members arranged in spaced relation to each other, and spacer means for retaining the bearing members in said spaced relation, the rotary and piston cam members each having a plurality of said centering detents one for receiving each of the bearing members, and said centering detents having a spaced relation corresponding to the spaced relation of the bearing members.

21. An apparatus according to claim 1, wherein said pressing means comprises said piston cam member arranged for reciprocation in a centering chamber for applying a resilient force against said bearing member, and fluid means for providing a pressurized fluid in said centering chamber so that fluid pressure causes said piston cam member to apply said resilient force and thereby provides said resistance force by causing said bearing member to oppose movement of said steerable member toward either side of said selected position; and wherein each of said centering detents further comprises opposing ramps arranged on opposite sides of said detent seat to receive said bearing member when said piston and rotary cam members move

relative to each other, said ramps being shaped so that said fluid pressure causes said bearing member to provide a return force biasing said steerable member toward said selected position during at least part of the movement of said steerable member to either side of said selected position.

22. The apparatus of claim 21, wherein each of said opposing ramps is fared into a corresponding track for receiving the bearing member upon movement thereof away from a corresponding detent, and wherein said opposing ramps are shaped so that said fluid pressure causes said moved bearing member to provide a return force biasing said steerable member toward said selected position during at least a range of the movements of said steerable member to either side of said selected position.

23. An apparatus according to claim 21, wherein said fluid means comprises a source of pressurized gas and means for supplying said pressurized gas as the fluid in said centering chamber, and control means for adjusting the amount of said gas pressure to vary said resistance and return forces.